THE AMAZON INDIAN AND EVOLUTION IN HEVEA AND RELATED GENERA

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With four plates

I.

TO-DAY the genus *Hevea* is one of the most important groups of plants to civilised man, for it is the source of an overwhelmingly large part of his natural rubber. Despite the fact that rubber is indispensable to modern civilisation, it is wholly possible that the earliest use man made of *Hevea* was merely as a source of food. Even now, the Indian who lives in the murky corners of the Amazon forest has little use indeed for the rubber-bearing latex of the tree. Nevertheless, the seeds of various species of *Hevea* are, in season, a regular and esteemed article of diet amongst many tribes of the northwest Amazon.

It is meet that a thorough study of the role of *Hevea* as a food be made. The subject is of intense ethnobotanical interest in itself, but there is yet a more compelling reason for examining this relationship between man and rubber trees. A recent series of thought-provoking articles (1, 2, 4, 10, 40, 41) implies that this curious relationship has acted as a catalytic factor in certain phases of the evolution of the genus. Far-reaching conclusions have been drawn. Some of these conclusions call for objective examination, lest they become so intricately elaborated, so confounded and so widely accepted that their critical evaluation turns out to be a much more difficult task.

In this paper, I propose 1) to review what we know of the history of the utilisation of *Hevea* as a food; 2) to discuss my own observations of this particular use of the rubber [2] tree in the northwestern part of the Amazon Basin; and 3) to evaluate the recently proposed hypotheses as to how this use may have affected evolution in *Hevea*.

There is a group of related genera in the Euphorbiaceae to which *Hevea* is usually assigned: the *Hevea-Micrandra-Vaupesia-Joannesia* complex. Forasmuch as the seeds of several species of *Micrandra* and *Vaupesia* are used by Indians in an identical way as a food, our discussion will necessarily include these genera. We would be warranted in assuming, I believe, that whatever evolutionary influence this use may have had in *Hevea*

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[2] In this paper, I use the term "rubber" or "rubber tree" to refer only to *Hevea*, and to refer to all species of Hevea, not merely the commercially important species, *H. brasiliensis*; the term *cunuri* refers to *Micrandra Spruceana*.

could be paralleled in the case of related genera growing in the same area and habitats. No discussion of *Joannesia* is needed, for its seeds have never been reported as a food.

II.

Preliminary to a discussion of any phase of evolution in these groups, a short summary of the genera in question would seem to be in order, especially so since there has been so much difference of opinion in the past in regard to their classification.

HEVEA Aublet

Described in 1775 by Aublet (3) from material collected in French Guiana, *Hevea* is by far our most important genus of rubber yielding plants. It is the source of more than ninety-five percent of the world's natural rubber, and most of this amount is produced by a single species: *Hevea brasiliensis*. The genus is native to South America, where it is

FIGURE 1. Aerial view of the forests of the Río Apaporis below the Falls of Jirijirimo, Colombia. The great massif of the Cretaceous, quartzitic Mount Isibukuri can be seen in the background. Much of the topography of the northwest Amazon (the basins of the Rio Negro and Río Caquetá) is of this rolling type with large areas which, unlike the eastern and central parts of the Amazon Valley, are never subjected to flooding. On this high, rolling hinterland the abundant species of *Hevea* are *H. guianensis*, *H. guianensis* var. *lutea*, *H. nitida*, and *H. pauciflora* var. *coriacea*.

known from the Amazon Valley, the upper Orinoco Valley, the Guianas and the Matto Grosso region of Brazil. Highly typical of the Amazonian "hylaea" (16), *Hevea* exhibits much morphological variability and chooses a wide range of ecological sites. Its members range from forest giants to shrubby, sometimes almost prostrate, treelets and are found growing in deeply flooded alluvial land, in acidic boggy sites, on high well-drained upland and on the tops of xerophytic quartzitic mountains. As in many groups of tropical trees, natural variability has led, in the past, to the description of too many specific concepts. At one time, specialists held that the genus comprised twenty or more species (18, 19, 21), but recent workers are in essential agreement that there are only eight or nine (4, 11, 13, 14, 31, 32, 33, 40, 41). Trees of *Hevea* are usually called *seringa* or *siringa* in Brazil, Colombia and Venezuela, *shiringa* or *jebe* in Peru and Bolivia.

1. **Hevea Benthamiana** Mueller-Argoviensis in Linnaea 34: 204. 1865.

An inhabitant of low alluvial flood-sites and often-times growing in all-year *Mauritia*-bogs, *Hevea Benthaniana* is one of the most distinct of the species. It occurs only north of the Amazon River in the northwestern part of the Amazon Valley and the upper Orinoco. It is especially abundant in the Rio Negro basin. It may reach a height of ninety feet but usually is a medium-sized tree. A yielder of rubber only slightly inferior to that of *Hevea brasiliensis*, *H. Benthamiana* is often tapped commercially, but it has never been used for plantation stock. Its latex is pure white. *Hevea Benthamiana* is easily recognised by the golden-brown indument on the under surface of its leaves. There appears to be comparatively little variability in this species in the undisturbed forest.

2. **Hevea brasiliensis** (Willd. ex Adr. de Juss.) Mueller-Argoviensis in Linnaea 34: 204. 1865.

With the exception of one small area west of Manáos, *Hevea brasiliensis* is apparently confined to areas in the Amazon Valley south of the Amazon River and to the Matto Grosso and Paraná (14). In most parts of the Amazon Valley, it is usually associated with periodically-flooded areas, but in the Matto Grosso of Brazil, in Bolivia and in the Madre de Dios in Peru, it abounds on high, well-drained upland areas, where it becomes a much taller and more corpulent tree, attaining a height often of 130 feet. As the outstanding species from a commercial point of view, *Hevea brasiliensis* has received by far the greatest amount of botanical study in the field. Because of our fuller knowledge of this concept, some workers have thought *Hevea brasiliensis* to be the most variable of the species; in reality, it is no more variable — and probably less so — than most of the other species. Its latex varies from a pure white to cream-white.

3. **Hevea guianensis** Aublet Hist. Pl. Guian. Fr. 2: 871. 1775.

The most widespread of the species, *Hevea guianensis* is found throughout the range of the genus and shows much morphological variability. Its

great range and its variability may possibly indicate that *Hevea guianensis* is one of the oldest species of the genus. Even though its cream-yellow latex yields a rubber of inferior quality, the species, like its variety *lutea*, is assiduously tapped over a wide area, especially in eastern Colombia. At home on well-drained upland or on high river-banks which are subject to light flooding for only a short period, *Hevea guianensis* usually becomes a gigantic tree more than one hundred feet tall, often overtopping the jungle canopy. This species and its variety *lutea* may be distinguished at once by their conspicuously erect leaflets.

3a. **Hevea guianensis** Aublet var. **lutea** (Spruce ex Benth.) Ducke et R. E. Schultes in Caldasia 3: 249. 1945.

Almost as widely distributed as *Hevea guianensis* itself, this variety can sometimes be distinguished from *Hevea guianensis* by its very conspicuously obovate and abruptly apiculate leaflets, but both vegetative and floral characters separating the two often intergrade. The latex of *Hevea guianensis* var. *lutea* usually is more deeply yellow than is that of *H. guianensis*.

4. **Hevea microphylla** Ule in Engler Bot. Jahrb. 35: 669, *t. 1, figs. j, k, l, m.* 1905.

Without doubt the most distinct species of *Hevea*, *H. microphylla* appears to be a strict endemic of the uppermost Rio Negro basin in Brazil, Colombia and Venezuela (35). It demands low land which, flooded often to a depth of ten feet for four months during the rainy season, retains a boggy condition throughout the year. The tree has a conspicuous and characteristic swelling at the base and tapers rapidly to a slender, flexuous trunk, often reaching a height of sixty feet and supporting a very sparse crown. The pistillate flowers have an unusually well-developed torus. The capsules, with leathery instead of woody valves, are pyramidal and pointed. The fruit does not dehisce suddenly, shooting the seeds appreciable distances as in all other known species; on the contrary, it opens slowly and drops the seeds directly beneath the tree. The white latex is very watery and almost completely lacks rubber, for which reason it is never gathered by tappers. Until recently, this concept has been called *Hevea minor* Hemsley, a synonym of *H. pauciflora* var. *coriacea*.

5. **Hevea nitida** Martius ex Mueller-Argoviensis in Martius Fl. Bras. 11(2): 301. 1874.

Formerly known as *Hevea viridis* Huber, this species is one of the most interesting members of the genus. Usually a medium-sized tree with a sparse crown, growing in light caatinga-forest on sandy soil, *Hevea nitida* sometimes becomes, in areas of light inundation, a stout tree up to ninety feet in height. One of its distinguishing characters is the very shiny upper surface of the reclinate leaflets. Its thin, white latex is of no value as a source of rubber; indeed, if its latex be mixed (as has often happened when new jungle areas were opened to tapping) with that of *Hevea Benthamiana* or

H. guianensis, it acts as an anti-coagulant (24, 28). The rather disrupted distribution of *Hevea nitida* includes almost the whole Amazon Valley and the uppermost Orinoco, but the species seems to be most abundantly developed in the Rio Negro basin of Brazil and in Amazonian Colombia.

5a. **Hevea nitida** Martius ex Mueller-Argoviensis var. **toxicodendroides** (R. E. Schult. et Vinton) R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. 13: 11. 1947.

A bushy treelet, usually not much exceeding eight feet in height, *Hevea nitida* var. *toxicodendroides* is known only from the isolated, remnant, quartzitic mountains of Cretaceous age in eastern Colombia (24, 26, 28). Here, occurring on sandstone which is almost devoid of soil, the treelet grows under severe conditions of psammophytic and chersophytic drought. Nevertheless, specimens which have been planted in rich alluvial soil at Urabá, Colombia, under excessive rainfall, retain their bushy habit of growth. Unlike that of *Hevea nitida*, the latex of this variety has a relatively high percentage of caoutchouc.

6. **Hevea pauciflora** (Spruce ex Benth.) Mueller-Argoviensis in Linnaea 34: 203. 1865.

Hevea pauciflora, known from the Rio Negro and upper Orinoco basins and from the Guianas, is not nearly so widespread nor abundant as is its variety *coriacea*. It is a rather corpulent tree with large, membranaceous (except in age) leaflets and very large seeds. The latex is white and has a low caoutchouc and high resin content.

6a. **Hevea pauciflora** (Spruce ex Benth.) Mueller-Argoviensis var. **coriacea** Ducke in Arch. Inst. Biol. Veg. Rio 239. Jan. 2, 1935.

Like *Hevea nitida*, with which it sometimes grows, this variety has a rather wide but disrupted range (15, 37). It is a small to medium-sized tree, seldom surpassing sixty feet in height, growing on rocky hillsides or high river-banks which are well drained and safe from the annual flood. The latex of *Hevea pauciflora* var. *coriacea* varies from whitish to a tawny yellow; it is never a pure white, as in the species. The leaflets, which are usually smaller than in the species, have a leathery texture from a few weeks after their appearance and become very thick-coriaceous, often somewhat marginate, in age. The seeds are very small to medium-sized.

7. **Hevea rigidifolia** (Spruce ex Benth.) Mueller-Argoviensis in Linnaea 34: 203. 1865.

A strict endemic confined apparently to the uppermost Rio Negro basin of Brazil, Colombia and Venezuela, *Hevea rigidifolia*, like *H. pauciflora* var. *coriacea*, with which it often grows, prefers high, well-drained, sandy or friable soil supporting a light caatinga-forest. It is commonly a medium-sized tree, sixty feet in height, with a sparse crown. The latex, which usually has a slightly cream-yellow hue, is poor in rubber and high in resin.

An outstanding characteristic of *Hevea rigidifolia* lies in the extremely thick-coriaceous and very strongly revolute-marginate leaflets which are always borne in a conspicuously reclinate position.

8. **Hevea Spruceana** (Benth.) Mueller-Argoviensis in Linnaea **34**: 204. 1865.

Hevea Spruceana occurs in great abundance on low and very deeply flooded river-banks along the Amazon River itself from its mouth up to about its confluence with the Içа or Putumayo and along the lower courses of the tributaries of the lower Amazon. The trunk is conspicuously bellied at the base, and the tree has leaflets which are usually more or less densely velutinous on the under surface. The flowers seem almost never to be yellow, usually varying between a purplish brown and brown colour, and are sometimes objectionably pungent-aromatic. As its watery, white latex is almost devoid of rubber, *Hevea Spruceana* has no commercial interest to the tappers. The capsule and seeds are the largest of the genus.

MICRANDRA Bentham

Micrandra (including those species formerly accommodated in *Cunuria*) comprises some 13 species, all confined to South America (36). The genus is probably rather closely allied to *Hevea*, but it has a much wider range. Known from the entire Amazon basin and from southeastern Brazil, the Orinoco drainage-area and all of southern Venezuela, the Guianas, as well as from the Magdalena Valley in Colombia, *Micrandra* would appear to be an old genus. Only one species — *Micrandra minor* — has been of any commercial importance as a rubber producer. As in *Hevea*, the species of *Micrandra* exhibit a predilection for a wide range of ecological sites, from river-banks to mountain-slopes and from areas of heavy to light rainfall, but none is known to prefer the permanently boggy sites chosen by some of the species of *Hevea*.

In Brazil and Colombia, certain species of *Micrandra* are known as *arara-siringa* or *cunurí*.

1. **Micrandra australis** (R. E. Schult. ex Baldw. et Schult.) R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 202. 1952.

Micrandra australis is a poorly understood species known from a high plateau between two tributaries of the Rio Madeira in the central part of the Amazon basin.

2. **Micrandra bracteosa** Mueller-Argoviensis in Martius Fl. Bras. 11(*2*): 290. 1874.

This species is very incompletely understood. Known only from several very old collections, it seems to be confined to coastal Brazil (Bahia).

3. **Micrandra brownsbergensis** Lanjouw Euph. Surinam, 34, *tt*. *7*, *8*. 1931.

A medium-sized tree occurring in the lowland rain-forests of Dutch and French Guianas.

4. **Micrandra elata** (Didrichs) Mueller-Argoviensis in Linnaea **34**: 142. 1865.

Micrandra elata is an apparently rare tree of medium-size known only from southeastern Brazil (Minas Geráis and São Paulo). It is the southeasternmost representative of the genus.

5. **Micrandra glabra** (R. E. Schult. ex Baldw. et Schult.) R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 203. 1952.

A seventy-five to one hundred foot tree, this species is known from British and Dutch Guianas and from Venezuela. It grows apparently in savannah forests associated with the ancient Venezuela-Guiana land-mass.

6. **Micrandra Gleasoniana** (Croiz.) R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 203, *t. 65*. 1952.

A tree up to sixty feet in height, known only from the Mazaruni drainage-area in British Guiana, where it appears to be associated with outcrops of the Venezuela-Guiana land-mass, *Micrandra Gleasoniana* is most conspicuous because of the dense yellowish, velvety indument on the under surface of the leaves.

7. **Micrandra Lopezii** R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 204, *tt. 66, 67*. 1952.

Micrandra Lopezii, a small tree of some forty-five feet in height, is a very strict endemic known only from several stations in the uppermost Rio Negro basin of Brazil and Colombia. It inhabits sandy caatingas where the forest is very light. It is apparently allied most closely to *Micrandra glabra*. The seeds are small for the genus. *Micrandra Lopezii* has an unbuttressed trunk, but there is a variant with well developed prop-roots: *M. Lopezii* var. *anteridifera* R. E. Schult.

8. **Micrandra minor** Bentham in Hooker Bot. Journ. **6**: 372. 1854.

Widespread and abundant in the Amazon Valley and the upper Orinoco basin, *Micrandra minor* is a gigantic tree, often attaining a height of one hundred and ten feet. The crown is very heavy, and the corpulent trunk is unbuttressed. This species prefers high river-banks which are inundated only at the height of the annual flood, and is never found in low-lying swampy areas. The very abundant, thick, pure white latex yields a rubber of high quality and has been tapped in the past for "Caurá rubber"; but, as the tree cannot be subjected to repeated and frequent tapping, it is not promising for planting. *Micrandra minor* superficially resembles *M. siphonioides*, and the two concepts have sometimes been thought to be identical. *Micrandra minor* never has buttresses, whereas *M. siphonioides* always has enormous tabular roots. The former species is a riparious tree,

whereas the latter always grows on sandy, well-drained upland soil. In the nerve axils, on the under side of the leaf of *Micrandra siphonioides*, there are dense tufts of yellowish hair, but the leaf of *M. minor* is wholly glabrous. The natives distinguish between the two, calling *Micrandra minor* by the Brazilian name *arara-siringa* and referring to *M. siphonioides* as *arara-siringa da caatinga*.

9. **Micrandra Rossiana** R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 211, *tt. 68, 69*. 1952.

Micrandra Rossiana has a widespread, though very disrupted, range in the northwestern part of the Amazon Valley in Brazil, Colombia and Venezuela, occurring always on high knolls far above the annual flood. It is especially abundant in the Vaupés of Colombia. With no appreciable flow of latex, this species is an unbuttressed tree up to about seventy feet in height. The prominently carunculate seeds are relatively large.

10. **Micrandra santanderiensis** Croizat in Journ. Arnold Arb. **24**: 169. 1943.

Obviously allied to *Micrandra brownsbergensis* and *M. elata*, this species is remarkable because of its distribution. The only species known west of the Andes, it occurs in the Magdalena drainage-area of Colombia.

11. **Micrandra siphonioides** Bentham in Hooker Kew Journ. **6**: 371. 1854.

This heavily buttressed caatinga-tree is abundant, albeit disruptedly distributed, in the northwestern part of the Amazon Valley from Manaos westward, being especially abundant in the Rio Negro basin of Brazil and Colombia. It is a poor yielder of latex and is never tapped. Its closest ally is *Micrandra minor*, with which it has often been confused. The crown is extraordinarily extensive, and it usually fruits in profusion, shedding great quantities of a medium-sized seed.

12. **Micrandra Spruceana** (Baill.) R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 217. 1952.

Better known under the binomial *Cunuria Spruceana* Baillon, this species is widespread on high, well drained soil in the western half of the Amazon Valley and the uppermost Orinoco. It occurs in Brazil, Colombia, Peru and Venezuela. In the Rio Negro basin of Brazil and in much of Amazonian Colombia, it is excessively abundant. It is a corpulent, well buttressed tree sometimes reaching ninety or one hundred feet in height. The capsules are borne in great abundance and yield large, glossy, reddish brown seeds very rich in oil. The white latex is very sparse and resinous and is never gathered.

13. **Micrandra Sprucei** (Muell.-Arg.) R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. **15**: 218, *tt. 70, 71* (upper fig.), *72, 73*. 1952.

One of the most abundant of the caatinga-trees of the northwestern Amazon, especially in the upper Rio Negro basin of Brazil, Colombia and Venezuela, *Micrandra Sprucei* was, for a century, known only from Spruce's type collection. It is better known as *Cunuria crassipes* Mueller-Argoviensis.

VAUPESIA R. E. Schultes

A monotypic genus which seems to stand phylogenetically between *Micrandra* and *Joannesia*, *Vaupesia* is unknown except in a very restricted part of the northwest Amazon, in the basins of the Apaporis and Vaupés Rivers of Colombia and Brazil (39). The one species inhabits rocky and sterile but well-watered sites usually alongside cataracts and rapids in the rivers, where there are either quartzitic or granitic outcrops.

1. **Vaupesia cataractarum** R. E. Schultes in Bot. Mus. Leafl. Harvard Univ. 17: *27, t. 12, 14.* 1955.

Vaupesia cataractarum grows in isolated pockets, but, where it occurs, it is found in great abundance. A corpulent tree attaining a height of eighty feet, this species is, in its foliage and fruits, so similar to *Micrandra Spruceana* that the Tukano Indians of the Vaupés River employ the same name for both. The tree fruits profusely, each capsule containing three large, dull brown seeds. It is of no value as a latex-tree.

III.

Reports concerning the use of rubber seeds as food constituted merely curious ethnobotanical information until very recently. About a decade ago, these reports were taken up and, through a series of successively more far-reaching postulations, comestible use by primitive peoples of rubber seeds was credited with having had directly or indirectly really titanic influences upon the evolution of *Hevea*. So firmly entrenched have these postulations become in the literature in this short time that it behooves us to study them with an eye alert to their soundness. It will serve our purposes best, if the postulations be here quoted in the words of their proponents and as they were presented, from their prudent beginnings to their present strident positiveness.

In 1947, Baldwin (4) and Seibert (40) mentioned the fact that the Indians of the northwest Amazon eat *Hevea* seeds, and they utilised it as one argument in a series which they advanced to explain certain presumed steps in the evolutionary history of the genus.

Baldwin (4) assumed that, when forest is felled for house sites, the natives spare *Hevea* trees either because the trees are a source of latex "or, in some areas, because the seed are eaten, or because the wood is poor fuel." He pointed out that such a practice would present "excellent opportunities for hybrid swarms to become established." To the best of my knowledge, this is the first time that the primitive and probably earliest use

of *Hevea* has been considered thoughtfully from the point of view of what effect it might have had on the evolution of the genus.

Keenly interested in the phyletic significance of certain differences which he had observed in the loss of oil from seeds of a number of species of *Hevea*, Baldwin (7) has implied a correlation between oil content of the seed and their use as a food.

> That seed of both *H. rigidifolia* and *H. Kunthiana* [usually known as *H. pauciflora*] lose oil in significant amounts suggests close genetic relationships between these species. Baldwin . . . stated that their seed are much alike and that the natives of the upper Rio Negro eat the seed of both species: he found a tree of *H. rigidifolia* that had been cut for its almost-mature seed and recorded that trees of *H. Kunthiana* are not uncommonly planted for their edible seed. Though the natives 'designate the latter tree *seringa*, they say it has seed like *cunury*.' Baldwin and Schultes . . . discussed the use of seed of *cunury* — i.e., of *Cunuria*, a genus with affinities to *Hevea* — as food of Amazonian Indians . . . And Baldwin . . . has mentioned the possibility of introgression between these genera. Pertinent here is the fact that *Cunuria* seed among my collections evidence no loss of oil. . . .
>
> That the Amazonian native seems especially to select for food the seed of *H. rigidifolia* and of *H. Kunthiana* and that oil escapes freely from seed of these species are reasons for according this phase of the genus particular study.

Seibert (41) took this thesis further, arguing as follows:

> Through its value as a food plant to the Indians of the Rio Negro region, it appears that *Hevea* became a semi-domesticated tree. Its domestication along the major waterways, in clearings, edges of villages and camp-sites followed a pattern of conscious or unconscious selection for seed production. The planting of certain species in the vicinity of other wild species substantially aided the process of interspecific hybridization. Once established in clearings, the mature hybrids and introgressive hybrids are (at least in part) capable of competing with the encroaching second growth. Several centuries of this slow process seem to have played a conspicuous part in the resultant hodge-podge of variables turning up as representative collections of *Hevea* from the Rio Negro. . . .[3] From present evidence, it appears that *Hevea pauciflora* has been the species of *Hevea* most cultivated by the Indians of the Rio Negro and upper Amazon.

Under *Hevea pauciflora* (in which he included *H. pauciflora* var. *coriacea*), Seibert (40) went farther by saying that "in the hundreds of years Indians have been along the Rio Negro they have . . . distributed the species outside of its natural habitat." He entertains the possibility that *Hevea pauciflora* got as far as Iquitos, Perú, through the agency of man. "It would not be too hard," he argued (40) "to presume that *Hevea pauciflora* may have been introduced into Iquitos before the white man arrived."

[3] There is a much greater development of speciation in *Hevea* in the northwest Amazon, but, on the basis of the available collections and on several years of field work along the Rio Negro and its western affluents, I venture to say that there is no greater variation here than in most other parts of the Amazon which are as well known. Certainly, so far as *Hevea* is concerned, there is no "hodge-podge of variables" in the area.

Seibert presented his postulations prudently, usually avoiding categorical statements. He undoubtedly hoped to stir up discussion and evaluation of his hypothesis. Unfortunately, there has developed a tendency recently to accept Seibert's suggestions *in toto* and to present them as well established and proven facts, with no inkling that they are highly hypothetical from beginning to end.

Anderson (1), for example, saw the problem as follows:

> Apparently the species was first cultivated for its edible nuts . . . Either accidentally or with intent, seedlings from wild trees came up in clearings where they were being used for food. These areas were often outside the natural range of that species or variety and sometimes within pollination distance of other species. Consequently, these isolated trees tended to be cross-pollinated. Under the primitive agriculture of these areas, clearings were occupied for a time and then deserted. As the disturbed land gradually reverted to jungle, there were many opportunities for the hybrid seedlings of the isolated nut trees to germinate and survive. They crossed back to the native species of that vicinity, and thus the process of introgression might have started in hundreds of little clearings in the jungle. The more or less casual use of *Hevea* for its edible nuts increased the natural introgression between some of the species. When man gradually learned that the latex of *Hevea* also had its applications, he already had at hand variable, introgressed, semi-domesticated populations, in which trees superior in latex were more likely to be found.

More recently, Anderson (2) has taken the same theme to much bolder lengths, weaving into the story as previously elaborated additional and highly imaginative aspects. He states in part:

> There is a great variation in the rubber content of the supposedly wild trees; some of the higher-yielding strains trace back to sites which are now part of the jungle but which indicate clearly that they had been village clearings before they were engulfed by the rapidly regenerating tropical brush . . . primitive man first domesticated the Pará rubber tree for its nuts . . . By doing this, they brought into their small and transient villages trees which were not just a random selection of the original wild species but just those with superior nuts, or a superior yield of nuts. In doing so, they frequently brought in trees which were not native to that immediate area . . . As these clearings were deserted, the alien trees crossed with those in the immediate vicinity and thus in more than one clearing there eventually developed mongrel swarms of Pará rubber trees, which had the heightened variability characteristic of mongrels. It was among them that some of our most potentially valuable breeding material was located when we eventually became much more interested in the milky sap than in the nuts.

In considering the "purity" of the *Hevea brasiliensis* material which was first imported into the Far East from Brazil, Dijkman (10) has cited some of Seibert's postulations in connexion with the use of *Hevea* seed as a food and has accepted as fact Seibert's thesis that the Indians spread *Hevea pauciflora* far and wide.

Seibert, in addition, has collected evidence of penetration of *H. pauciflora* into the *H. brasiliensis* complex referred to above. He assumes this probably first

began as a result of the natural enlargement of the original habitat; but the process seems to have been considerably hastened by the autochthonous inhabitants of the continent. The seed of this species and/or its expressions are eaten by the Indians, who carried the seed with them on their migrations and brought *H. pauciflora* under cultivation in their new settlements. . . . This man-caused spreading has created the impetus for its adaptation to a wide range of extreme climatic conditions.

Even a hasty review of the several passages which I have quoted above shows that an extraordinary amount of theoretical importance is being given to reports on the use of *Hevea* seeds as a food and far-reaching assumptions are being made in an attempt to build up a plausible sequence of events to fit into the hypotheses propounded. A moment's hesitation and thought will recommend caution and forfend unbridled play.

What, then, are the ethnobotanical facts, and how do these facts, bereft of unfounded trimmings, fit into the hypotheses which we have just reviewed?

IV.

Oddly enough, historical references give us very little information on the use of *Hevea*, *Micrandra* or *Vaupesia* seeds as a comestible. There may be several explanations for this. One reason which we must bear in mind is the paucity of reliable ethnobotanical records for the vast Amazonian forest area. Another may be the ease with which travellers could have overlooked this strange food, for the seeds of these jungle trees are normally available for but a very short time (about one month) each year and, as they do not keep, they must be used at once. It is hard to account for the dearth of references to this custom, even in the several detailed anthropological accounts of the Indians of the northwest Amazon written by men who had spent many months, even years, in the region. This silence in anthropological writings is all the less understandable when one realises that sometimes tribal festivals or dances are centered around the harvest of *seringa* or *cunurí* seeds for food.

To Fusée Aublet must go the credit of first reporting the use of rubber seeds as a food. In his description of *Hevea guianensis*, in 1775, he (3) wrote of certain Indians of French Guiana:

> The Galibis [Caribs] and Garipons carefully gather the nuts from the fruits of this tree. They keep them and eat them with enjoyment. I have witnessed their assiduity in collecting the seeds when they come upon these trees on trips that I have made with them; I have imitated them. I have eaten many of these nuts without feeling any disturbance whatsoever.

This passage merits attention not only as the earliest report of this use of rubber seeds but also as the only report which apparently ignores their cyanic content. It is not easy to interpret Aublet's statement that the Indians "keep" the seeds, for they spoil with great rapidity. Furthermore, the seeds of *Hevea* and its allies *Micrandra* and *Vaupesia* are known to be

highly toxic to man, until the cyanic poisons are removed by long soaking or by boiling.

The next reference to the eating of *Hevea* seeds is that of the botanist Richard Spruce who spent seven years in the Amazon Valley and who, through his collecting, greatly advanced our knowledge of *Hevea* and its relatives. In 1854, Bentham (9) published Spruce's manuscript notes on *Hevea*, and we find the following report:

> The seeds are an excellent bait for fish. Macaws eat them greedily, but to man and quadrupeds they are poisonous in a fresh state. The Indians on the Uaupés render them eatable in this way: after being boiled twenty-four hours, the liquor is strained off, and the mass that remains has something the colour and consistence of rice long boiled. Eaten along with fish it is exceedingly savoury.

It is of the utmost import here to make note that Spruce did not designate any *one* species of *Hevea* as a source of edible seeds. His discussion referred to the genus as a whole. There can be little doubt that Spruce meant that the Indians of the Vaupés River used any or all of the species as a source of comestible "nuts."

During my more than a decade of field work on *Hevea* and its relatives in the Amazon Valley, I have given critical attention to the part which these plants play in the economy and lore of the Indians, especially of the more primitive tribes which do not engage in rubber-tapping work.

The first observation which I must make is that, as far as the literature and my own observations attest, the seeds of *Hevea* and *Micrandra* are used regularly as an annual food exclusively in the northwestern part of the Amazon Valley — that is, in the basin of the Rio Negro in Brazil and in the Comisarías del Vaupés and Amazonas in Colombia. I have never heard reports amongst the inhabitants of other parts of the Amazon Valley, and botanists who have worked elsewhere tell me that they have not heard of the custom. Seibert, who spent a number of years in eastern Peru and who became extremely interested in Spruce's report of the food-use of rubber seeds, does not record it from any part of Peru. Dr. Adolpho Ducke, who has collected plants in all parts of the Amazon Valley for half a century, agrees that this aboriginal custom is peculiar to the northwest. One must needs, of course, distinguish between the regular and often ceremonial consumption of the seeds, on the one hand, and the occasional eating of them in isolated instances as a last resort during great famine, on the other hand.

The fundamental importance of this fact is at once evident. Restricted culture-trait that it is, the habit of eating rubber seeds could not have had the widespread effect postulated by Anderson and Dijkman. Baldwin realised that this use of the seeds was localised, but Seibert stated that it was a custom "within the Amazon Valley itself" and suggested man as an instrument of spread over great distances. Dijkman had the Indians carrying the seeds of *Hevea pauciflora* "with them on their migrations and brought *H. pauciflora* under cultivation in their new settlements," and he

speaks of "this man-caused spreading" as having helped adapt the species to a "wide range of extreme climatic conditions." Even were the custom of eating the seeds widespread, it would be impossible for Indians migrating any distance in open dugout canoes to carry along the notoriously short-lived rubber seeds in a viable state.

There is a second important observation which I must make. It is very probable that the seeds of all of the species of *Hevea* occurring in the northwest Amazon are eaten.

There would seem to have been a tendency to lay more stress on the importance of *Hevea pauciflora* as a source of food than on any other species. This must be examined critically, for there would seem likewise to be an implication that this species, partly because of its "cultivation" and "domestication" through man's interest in it as a source of food, has led to a great degree of intraspecific variation and has similarly caused this species to "penetrate" others and so influence markedly the course of development of the genus. Baldwin (4, 5, 7) reported that the natives of the upper Rio Negro select the seeds especially of *Hevea pauciflora* and *H. rigidifolia* for food; and Seibert (41) felt that the available evidence pointed to *H. pauciflora* as the species preferred.

There is no basis for the supposition that one or two species are preferred over others. In the northwest Amazon, all known species of *Hevea* but two — *H. brasiliensis* and *H. Spruceana* — are represented. Of the six species occurring in the region, the seeds of five of them are used as food. Whilst living in Indian sites in eastern Colombia, I have eaten the seeds from several species myself. Ducke (12) reported that the natives living along the Curicuriarí eat the seeds of more than one species of *Hevea*.

Hevea microphylla seeds, which are unusually large for the genus, do not seem to be gathered for food; and I think the reason for this is only the difficulty of harvesting them. *Hevea microphylla*, as we have seen above, grows in almost permanent bogs, and the *sarapó* and other fish, spawning in this season in the wake of the flooded forests, snap the seeds up with great alacrity. The capsules do not open with explosive violence, so the seeds are not shed in quantity, as in other species; when the capsule opens gently, the seeds fall one by one into the water below. The tiny seeds of *Hevea nitida* var. *toxicodendroides* are, apparently, never gathered for food because of their size.

If there be any rubber trees the seeds of which are more commonly used as food in the northwest Amazon, it is neither *Hevea pauciflora* nor *H. rigidifolia* but *Hevea guianensis* and *H. guianensis* var. *lutea*. This is due not to any preference but to the greater abundance and availability of these trees. I have seen collecting parties gathering the seeds of *Hevea guianensis* and its var. *lutea* amongst the Makunas of the lower Apaporis River, the Taiwanos of the Kananarí and the Kubeos of the Vaupés in Colombia. I have eaten mash from the seeds of *Hevea guianensis* in the country of the Kuripakos at the headwaters of the Guainía in Colombia. The Yukunas and Tanimukas of the Miritiparaná in Colombia make unleavened cakes from the seeds of *Hevea guianensis* var. *lutea* and of *Micrandra Spruceana*

as the principal starch food in their beautiful annual Dance of the Cunurí or Wĕ-ra. In this case, there seems to be a preference for seeds of *Hevea guianensis* var. *lutea* over those of *H. nitida*, even though, when the seeds are used as food in everyday life without any connexion with this semi-religious dance, both are used indiscriminately. There is probably some ceremonial reason for the choice, for the preference is a strict trait. The only "explanation" which I could get was that *Hevea guianensis* var. *lutea* is "cousin to" *Micrandra Spruceana*. Both tribes have distinctive names for these two rubbers: the Yukunas refer to *Hevea guianensis* var. *lutea* as *hĕ-che* (a name interestingly similar to that of *Micrandra Spruceana*: *yĕ-cha*) and to *H. nitida* as *ya-wá-ro*; the Tanimukas refer to the former as *wãn-hoó-a*, to the latter as *wãn-hoó-a-ma-ka-na*. The Miritiparaná is the only region in which I have found the mash or pulp from the seeds of either *Hevea* or *Micrandra* elaborated into cakes.

Hevea nitida is very widely employed in the northwest Amazon as the source of edible seeds. This tree, as we have seen, grows either in jungle which is but slightly flooded at seed-time or in upland forest on well-drained sand. Needless to say, it is usually the latter instead of the former habitat to which the Indians, in search of rubber seeds, repair. The reasons are clear. It is much more difficult to walk through a flooded forest, and the seeds are much less abundant because of the great quantities eaten by spawning fish. I have seen seeds of *Hevea nitida* gathered for food or eaten in Colombia by the Taiwanos and Kabuyarís of the Kananarí, the Tukanos, Desanos, Kubeos and Gwananos of the Vaupés, the Yukunas and Tanimukas of the Miritiparaná and, in Brazil, by the Tukanos of the Uaupés and Negro. Along the banks of the Vaupés River above Mitú, *Hevea guianensis* var. *lutea* and *H. nitida* often grow intermixed in the forests and, in this case, the Kubeos gather both indiscriminately, showing no preference for one over the other. This is likewise true amongst the Tukanos of the Tikié in Brazil.

I have not seen *Hevea Benthamiana* seed used, but the Kuripako Indians along the lower Guainía and a few Mirañas on the Caquetá in Colombia have informed me that this species may be used as a food, and Baldwin (5) reports its use on the Uaupés River of Brazil. It is easily understood why, in a region with highland species as well, *Hevea Benthamiana* would be neglected as a source of seeds: at harvest time, the rivers are at their highest, and *Hevea Benthamiana* stands in from three to ten feet of water.

There remain to discuss only *Hevea rigidifolia* and *H. pauciflora*, the two species which Baldwin suggested were the most important as a source of food-seed. *Hevea rigidifolia* is a comparatively localised species, but, as it grows in abundance in pockets of light forest on well-drained sandy soil, it is visited by the natives who live in its vicinity. It is eaten in quantity by the Tukanos and Desanos of that part of the Vaupés and Papurí Rivers which form the boundary between Brazil and Colombia. *Hevea pauciflora* seeds seem to be eaten mainly by the natives along the upper course of the Negro and the seeds of *H. pauciflora* var. *coriacea*,

not well liked because of their smaller size, are used in several areas along the Vaupés, Guainía and Apaporis Rivers in Colombia.

As pointed out above, the Indians along the main course of the Amazon River are not known to eat rubber seeds, unless conditions of famine prevail. It will be of interest here to record that I saw a group of Tikunas near Leticia, Colombia, prepare seeds of *Hevea brasiliensis* and eat the mash with baked fish. These Indians, who were engaged in collecting, under my direction, several tons of rubber seeds (27), had eaten all their fariña meal and were forced to turn to rubber seeds. They made it clear that these were only an emergency food. I mention this merely because I have not been able to find any reference on the edibility of the seeds of *Hevea brasiliensis*.

From the foregoing information, it ought to be clear that the seeds of most, if not all, species of *Hevea* can and are taken as food in the northwest Amazon.

It might be worthwhile here to look at the situation in *Micrandra* and *Vaupesia*.

Again we turn to Spruce for our earliest knowledge of *Micrandra* seed as a food. On labels of specimens of *cunuri* (*Micrandra Spruceana*) collected in the uppermost Rio Negro basin in 1853 and preserved at Kew, Spruce made the following annotation (8):

> On the Uaupés and around São Gabriel [Estado do Amazonas, Rio Negro, Brazil], a large tree obviously allied to *Siphonia* [*Hevea*], called by the Indians *Cunurí*, is frequent in the forest. It has large arched buttresses at the base, like the *uacu* [*Monopteryx Uaucu* Spruce ex Benth.], from which it is distinguished by milk flowing from it when wounded. I have not yet seen its flowers or fruits, but the Indians describe the latter as tricoceous, quite as in Siphonia, and they use the seeds in a similar manner. These being boiled 24 hours yield a small quantity of oil, which serves for lamps. The pulpy mass into which the seeds have now fallen is packed in a basket and kept under water 3 days to sweeten; when taken out, it has a pleasant taste and no ill smell. It is eaten without the addition of anything else and may be kept a long time, but if the seeds have not been well boiled, it is a quick poison, and Indians have fallen victims to its incautious use.

In 1854, Spruce (19) reported that from the seeds of "*cunurí*, abundant on the alto Rio Negro, Orinoco, Casiquiare, Pacimoni, etc., the Indians prepare a paste resembling cream-cheese in appearance and taste. The seeds are first boiled and then steeped for some days under water, after which they are broken up by the hand. In the boiling, a quantity of oil is said to be collected . . . it is said to be as bitter as andiroba oil, but to afford an excellent light."

Apparently nothing more was written on *cunuri* seeds as food until recent years. Referring to *Micrandra Spruceana*, Ducke reported it for the Indians of the upper Rio Negro in 1934 (20). In 1943, Paul H. Allen (herbarium specimen *Allen 3063*) recorded a comparable use of *cunuri* by the Tukanoan Indians living on the Rio Papuri, an affluent of the

Vaupes and part of the boundary between Brazil and Colombia. In 1944, Baldwin found the seeds of *cunuri* eaten in the upper Rio Negro-Rio Uaupes region of Brazil (Baldwin et Schultes loc. cit. 344). And, in 1945, I (25) called attention to the use of *cunuri* seeds as food on the lower Caqueta and its affluents in Colombia:

> The seeds of *Cunuria Spruceana* apparently contain a cyanide and, according to the natives, are extremely poisonous when taken internally in the crude state. The Indians of the lower Caquetá, however, consume quantities of the seeds in the form of a greyish mash which is prepared by boiling the pulp in three waters to remove the poison. This mash has a peculiar taste, somewhat like burnt potato. According to the natives, salt must not be added to this mash.

This was the first of many observations pointing to the value of *Micrandra Spruceana* as a food. Since then, I have witnessed the preparation of this food and have, on a number of occasions, partaken of it myself. *Micrandra* and *Hevea* fruit simultaneously. The seed of *Micrandra Spruceana* is much more highly esteemed than that of any other species of *Micrandra* and more than that of any *Hevea*, wherefore, if *Micrandra Spruceana* occurs in abundance in a given region, very little *Hevea* seed is gathered. *Micrandra Spruceana* grows on light sandy soil which never floods, the tree fruits prodigiously and the seeds are large and full of a firm pulp which handles easily in boiling. In former years, the oil which came to the surface during boiling was used in lamps, so that these seeds were rather valuable in the native economy.

According to reports which I have gleaned in the field, *cunurí* seeds are eaten by the Barasanas, Desanos, Gwananos, Kabuyaris, Karihonas, Kubeos, Kuripakos, Makunas, Miranas, Taiwanos, Tanimukas, Tatuyos, Tukanos and Yukunas in eastern Colombia. They are likewise used by some of the natives in the upper Rio Negro basin of Brazil and possibly also in the very uppermost Orinoco. I have witnessed the preparation and use of these seeds by the Karihonas, Yukunas and Tukanos. In all cases are the preparations similar: several boilings are always employed to remove the cyanic poisons.

Without a doubt, one of the most interesting ways of using *cunurí* seeds is the making of unleavened "bread" or casabe for the *Wĕ-ra* or Dance of the Cunuri of the Yukuna and Tanimuka Indians. A most beautiful dance, the Wĕ-ra, with the whole tribe participating, lasts for forty-eight hours, This dance takes place during the seeding-time of the *cunurí*, which is normally in March. Great groups of young men make ceremonial trips to areas of the forest where *Micrandra Spruceana* grows in abundance, large baskets are woven on the spot, and these are filled with seeds. Carried back to the house where the dance is to be held, the seeds are given over to the women who immediately start the process of boiling and washing out the poisons. The process is very similar to that used to prepare the meal or fariña from poison *Manihot*, and, indeed, it is the same or a similar poison which must be removed. After several boilings and washings, the damp mash is gently toasted on a flat plate over the fire and is reduced to a fine

greyish white meal. This is then made into *casabe* or unleavened bread, in much the same way as fariña (from *Manihot*) is used to make *casabe* cakes. Often the *cunuri* flour is, as pointed out above, mixed with flour from the seeds of *Hevea guianensis* var. *lutea*, but usually *Micrandra Spruceana* is used alone. The casabe cakes thus prepared are, together with smoked boar- or tapir-meat, the chief food of the dance.

The seeds of at least two other species of *Micrandra* are eaten in the northwest Amazon, but they seem to be used much less frequently than *M. Spruceana*. Along the Papuri River, in Colombia and Brazil, the Tukanos sometimes gather the seed of *Micrandra Sprucei* which are strewn abundantly on the floor of the sandy caatinga forest where this species is so common. *Micrandra Sprucei* perhaps has more oil in its seeds than has *M. Spruceana*. Its Tukano name *wa-só-nĕ-nĕ* means "light-rubber" ("wa-so" = *Hevea* and "nĕ-nĕ = light), probably in reference to the use of the oil boiled from the seeds to light lamps. On the Piraparaná River, the seeds of *Micrandra Rossiana* are used as food. In all of these species, the process of boiling the seeds several times to remove the poisons and oils is identical.

It will be of interest to point out that the seeds of *Micrandra glabra* have been reported (8) as "edible" in British Guiana.

Large and fleshy, the seeds of *Vaupesia cataractarum* are a favourite food of the Desano Indians along the Vaupes River between Mitu and Javarete. The extraordinarily abundant harvest each year attracts bands of Indians, and huge canoe-loads of seeds are taken back to malocas in the neighbourhood. So far as I could learn, the method of preparing these seeds is the same as for *Micrandra*. The great profusion of seeds and the ease of gathering them on the high, well-drained slopes near rapids account for the natives' predilection for *Vaupesia* over all species of *Micrandra* and *Hevea*.

What has been outlined above would seem to show rather positively that any postulations resting on the supposition that the Indians choose only one or two species of *Hevea* as a food-source are without foundation in fact.

We must next turn our thoughts towards a consideration of the claims of cultivation or "domestication" of *Hevea* as a wild nut tree. What are the facts in this regard?

Both Seibert and Baldwin base their principal postulation on the fact that along the Rio Negro, where they feel that *Hevea* shows especial variability, the Indians eat rubber seeds. Seibert further allows himself to suggest that it was a custom "within the Amazon Valley itself" for "many an Indian to transplant seedlings from jungle to dooryard." This custom I have never seen amongst Indians. Indeed, I have never seen a *Hevea* tree growing — either planted or as a survival from felling — in the garden of the house of any primitive Indian anywhere in the Amazon Valley, including the northwestern part.

Here, we must distinguish between the primitive aborigine and the civilised rubber tapper (be he pure Indian, white or half-breed), who, in felling a few square feet of virgin jungle for his temporary shack, where he lives in the dry season only whilst tapping rubber, will almost never sacri-

fice a wild *Hevea* tree. The tappers' little palm-thatch huts and their clearings often will be lorded over by two or three majestic rubber trees that have been spared, in part because they are tapped on the tapper's regular daily rounds and in part for sentimental reasons ("the goose that lays the golden egg"). There is no such custom as planting in these little jungle plots. Nor are the tappers interested in the seeds as a source of food, partly because it is only the uncivilised Indian apparently who will eat them and partly because the seeds fall at the time of high water, when the tapper and his family never use the hut, which is under water, but have moved back to a town to their permanent home.

Even were we to vouchsafe that the tappers planted seedlings or spared trees near their temporary jungle dwellings, it would be irrelevant, insofar as any appreciable effect which these isolated trees may have had on the evolutionary course of the genus. For, prior to a century ago, there was no widespread use of rubber and, consequently, no tapping industry had as yet grown up which brought thousands of workers into intimate association with wild rubber trees. Even if the isolated trees spared by the lonely tapper near his hut had had the extreme effect through hybridisation with other trees of the vicinity, which Seibert and Baldwin propose and Anderson and Dijkman accept, the effects would not yet — in only one hundred years — be seen on the large scale and over the vast area that have been suggested. Nor can such casual cultivation be termed "domestication."

That Anderson considers the effects to have been appreciable over a wide area for hundreds of years is evident when he says (1):

> When man gradually learned that the latex of *Hevea* also had its applications. he already had at hand variable, introgressed, semi-domesticated populations. in which trees superior in latex were more likely to be found. The extent and frequency of introgression must certainly vary greatly with the type of agriculture that is being practiced. Under the jungle-clearing pattern. like that just described for *Hevea*, it must have been at a maximum.

And further evidence of Anderson's lack of knowledge of Indian life in the northwest Amazon is shown by his statements that primitive man, having domesticated the rubber tree for its seeds, "brought into their small and transient villages" for planting trees selected for "superior nuts or a superior yield of nuts." This implies that the Indian selected for seeds, which, of course, with his very rudimentary agriculture, he would never have done, even had he planted the rubber trees.

Anderson refers to "supposedly wild trees" which he pictures as populating sites "now part of the jungle, but which indicate clearly that they had been village clearings before they were engulfed by the rapidly regenerating tropical brush." The truth of the matter is that the climatic climax of the northwest Amazon, as in other tropical rain-forests, is extraordinarily slow at taking over cleared areas, through numerous secondary successions. Literally centuries pass before the virgin or primary forest asserts itself, and one need not be a botanist to point out a patch where human dwelling

once disrupted the natural cover. This is so well known (23) that it need not here be discussed in any detail.

Anderson's statement that the "supposedly wild trees" of secondary communities supplied "some of our most potentially valuable breeding material" for high yield of latex is not borne out by the record of selection of élite jungle trees which botanist-explorers of the United States Department of Agriculture carried out in the Amazon Valley during the past ten or twelve years. Almost all of the most promising selections made by these botanists in Brazil, Colombia and Peru were of individuals growing in primary forest. In my own work of selection, for example, I was wont to avoid trees not in the climatic climax forest because of possible external influences on yield of latex which unnatural conditions in successive forests may have had.

It is true that, here and there along the Rio Negro and lower Uaupés in Brazil, groups of rubber trees — representing usually *Hevea guianensis* and *H. pauciflora* — grow near habitations or at abandoned house-sites under conditions that suggest that they might have been planted. I have seen such sites, and I have not the slightest doubt that they were planted. But this cultivation, it is of the most extreme interest to point out, is recent, dating no earlier than the beginnings of the rubber boom in the middle of the last century. And, in all cases, they are found at the sites inhabited by *caboclos* or half-breeds, never at settlements of uncivilised Indians. These people, though they are not of pure Indian blood and are civilised, may use *Hevea* seeds as a food, *but only when famine threatens*, not with the regularity and in the near-ceremonial way of the primitive Indian. And it must be emphasized here that the sites where one finds rubber trees under conditions suggestive of cultivation are not many. Surely, this "cultivation" would have to have been far more widespread and common to have had anywhere near the influence through hybridisation and introgressive hybridisation which Anderson and Dijkman present as established history.

If we contine our critical examination, we find that it is doubtful in the extreme that the *Hevea* trees which we see growing near houses along the Rio Negro were planted deliberately as a source of food. They may have been set out or spared in felling merely because they were "seringueiras" (rubber trees), even though neither of these two species is the one that is widely tapped for rubber along the Rio Negro. There is, nonetheless, an innate aversion to destroying any sort of rubber tree. And we must likewise consider the possibility that, as in the case of several other trees which yield no economic product, the rubber trees were set out merely as curiosities or ornamentals. Be that as it may, the unadorned facts about cultivation are these: (a) primitive Indians have not cultivated and do not now cultivate or care for rubber in any special way in their farms; (b) what little cultivation there is has been done by civilised inhabitants engaged directly or indirectly in rubber tapping; and (c) such cultivation on the Rio Negro is of relatively recent incipience and is extremely limited and localised.

A moment's thought will elucidate some of the reasons why the Indian never cultivates rubber and *cunurí* trees as a source of food.

Before the days of their reduction to civilisation, the Indians probably gathered *Hevea* and *Micrandra* seed as they do to-day: from wild trees. Many are the wild trees in the jungle that are visited every year in their fruiting time by Indians who often journey for several days to gather the nuts. I have seen this repeatedly in the Colombian Amazonia. No Indian relies upon rubber or *cunurí* trees planted or left standing in the yuca and coca fields around his house. All, without exception, garner their supply from the forest. When one lives long enough with these people, one realises the obvious and logical reason for this custom: the Indian enjoys such a harvesting trip through the jungle. It is a harvest that takes place but once a year, and it has, through the ages, come to be rather a ceremony or a kind of hunting task much to the Indian's liking. It is man's sport, whereas agriculture is left to the women. He would never think of giving up this enjoyment for the dullness of picking up the seeds near his house.

An Indian will live but a few years at one site. When he fells a patch for a house-site, the soil is leached out in a few years, and the leaf-cutting ant usually has multiplied to such an extent that it is a physical impossibility to continue to inhabit the site. Why, then, should he plant a tree that will not bear fruit in any appreciable amount under fifteen or more years, especially when the woods around his house or within easy journey are full of rubber trees? The answer is, of course, that he does not plant it at all. He might leave an occasional tree standing when he fells, but, as pointed out above, I have yet to see a rubber tree spared in the vicinity of a primitive Indian's dwelling.

Still another — and perhaps the most important — reason for not planting *Hevea* is fear of falling trees near dwelling places. None of the Indians of the northwest Amazon allows isolated trees to remain anywhere near the sites chosen for house-raising. The forest is felled clean: not one tree of any size is left standing and none is planted. Wind-storms in the Amazon are not infrequent and the sturdiest-looking trunk might easily be hollowed by rot and termite and an easy prey to the first strong blow. About the tallest tree that one sees near Indian habitations is the palm, *Guilielma speciosa*, but, as this medium-sized fruit-tree is rarely, if ever, victim of rot and, as its crown is light, it does not present the danger of falling that so often attends dicotyledonary trees of the forest.

The all-important theme in the postulations presented by Baldwin, Seibert, Anderson and Dijkman is that cultivation for edible seeds created optimum conditions for introgressive hybridisation. They give introgressive hybridisation supreme importance in *Hevea* evolution. It is not my purpose in this paper to discuss the role which this process may or may not have had, except to say that I hold that *Hevea* is probably no more variable than many other genera of tropical trees and that introgressive hybridisation has not had anywhere near the importance which is claimed for it. It is a temptation to overwork new approaches such as this, and especially so when "evidence" can be elaborated to present a

plausible series of arguments. I need not consider introgressive hybridisation here in detail simply because, as the summary and conclusion below bring out, the conditions which are stated to encourage wide-scale crossing and back-crossing to native species of *Hevea* do not exist and never did.[4]

Even though it be quite clear that extensive hybridisation of species of *Hevea* has not come to pass as a result of "domestication" of the rubber

FIGURE 2. Communal Makuna Indian house or *maloca*, Río Popeyacá, Colombia. Even though, in some tribes, the forest is close to houses, isolated forest trees are rarely, if ever, left standing near dwellings. Amongs most Indians of eastern Colombia, enormous clearings are made in the centre of which the house is built; in this case, too, all trees of any size are felled. The palm which is planted near the dwelling is *Guilielma speciosa*.

[4] Since the preparation of this paper, I have had the opportunity of reading an extremely interesting article by J. G. Bouychou of the Institut Français du Caoutchouc in Paris ("Note sur l'amelioration de l'Hevea" ms. (1955). Bouychou has postulated, as a partial basis for his proposed program of *Hevea* improvement, that the wild rubber trees in the Amazonian forest are highly inbred. This has resulted, according to Bouychou, from the wide isolation of the individual trees. The discovery that midges are the chief, if not the only, natural pollinators of *Hevea* and that *Hevea* pollen normally is not shed as far as the usual distance between individual trees in the forest are offered as support of this postulation. Without entering into a thorough examination of Bouychou's novel point of view, I may say here that many field observations which I have made in the forest as well as some of the results of recent selection and breeding work would seem to support the hypothesis which, of course, is diametrically the opposite of that proposed by Baldwin and Seibert.

tree for food, we still must grant that natural hybridisation probably has had some part in the evolution of the genus. We know that there are no barriers to hybridisation between the species, all of which have been crossed artificially.

In areas where man has caused great upheaval in the natural vegetation, we have undoubted proof of crossing. This is true of such places as the outskirts of the towns of Manáos and Iquitos (13, 37, 40). Specimens collected in such localities exhibit extremes of variation and all possible intergrades, some of which have erroneously been described, in the past, as varieties or forms. Trees left standing alone in extensively cleared areas are disrupted in their flowering rhythm and blossom almost all year through. This, together with their proximity with no interfering forest canopy, permits different species to cross freely. But even this clearing, extensive as it is in several localities, has happened only in recent times and can have had no appreciable effect on generic evolution.

Conditions are very different in the forest. Sometimes — though not so frequently as often supposed — two or more species grow together. I have noticed in the Amazon, however, that each species seems to have its own flowering time. To be sure, all species of *Hevea* flower at the beginning of the dry season, but all do not blossom in strict simultaneity. Pistillate flowers in *Hevea* are known to have a relatively short period of receptiveness (three or four days in *H. brasiliensis* (17)). There is enough disjunctiveness in flowering times to prevent appreciable natural hybridisation. That there is really little crossing in nature is borne out by long study of trees in the field and by close examination of herbarium specimens, both of which indicate that *Hevea* is not excessively variable.

This may seem to be at sharp variance with those who see every variation as evidence of "penetration" of genes from alien species. It is not, however, at variance with what I have found in the field, and Ducke (15), after more extensive field work on the genus than any living botanist, concurs. Consequently, I am forced to differ most vehemently with those who consider that in wild *Hevea* "introgression . . . is readily perceptible and of great biological import . . ." and that "one can find its influence . . . for all the species" (6).

SUMMARY

1. The Indians of the northwest Amazon utilise the seeds of a number of species of *Hevea*, *Micrandra* and *Vaupesia* regularly each year and sometimes ceremonially as a food.

2. Recent hypotheses have postulated that a) because of their interest in *Hevea* as a food-plant, the Indians cultivated trees which were selected for superior nuts or yield of nuts; b) species were carried by Indians for planting to areas far beyond their natural range; c) trees of very different provenience were planted together; d) these cultivations were later abandoned to the jungle; e) the plantings greatly enhanced the opportunities for hybridisation, and the hybrid offspring in turn crossed back to the

native, local species; f) this led to "mongrel swarms" with the excessive "variability characteristic of mongrels."

3. An exposition of the facts as found through long field work in the northwest Amazon does not support these hypotheses because a) the Indian uses seeds from wild trees and never cultivates them; b) trees occur near a few house-sites under conditions which might possibly be cultivation, but these were not planted out by the primitive Indian who eats seeds and are of such recent cultivation that they could not have had any appreciable effect on the evolution of the genus; c) due to its very short-lived seeds, *Hevea* could not be carried about by Indians over wide areas on their migrations.

CONCLUSION

It would appear that, contrary to previous suggestions, the claims as to the effect of cultivation and "domestication" of rubber resulting from its use as a food, while plausible on the surface, are unwarrantably sweeping and their soundness suspect. It is altogether probable that man has had little, if any, appreciable influence on the overall course of evolution in the genus *Hevea*.

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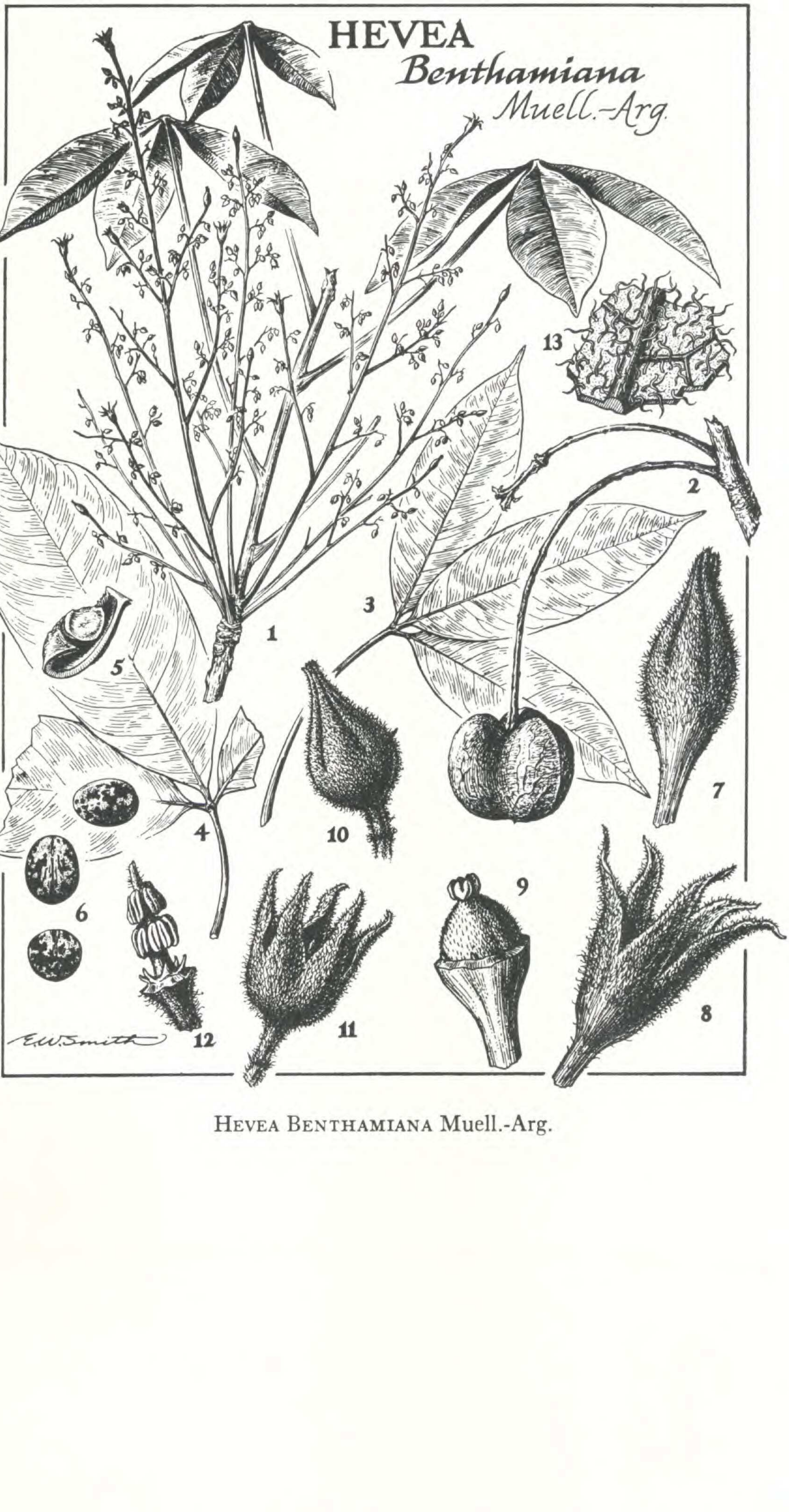
EXPLANATION OF PLATES

PLATE I. *Hevea Benthamiana* Muell.-Arg. 1) Flowering branch, about ½ natural size; 2) Fruiting branch, about ½ natural size; 3 and 4) Leaf variations, about ½ natural size; 5) Valve of capsule, about ½ natural size; 6) Seeds, about ½ natural size; 7) Pistillate bud, about 5 × natural size; 8) Pistillate flower, about 5 × natural size; 9) Ovary with calyx removed, about 7½ × natural size; 10) Staminate bud, about 5 × natural size; 11) Staminate flower, about 5 × natural size; 12) Staminal column with calyx removed, about 7½ × natural size; 13) Section of under surface of leaf, about 7½ × natural size.

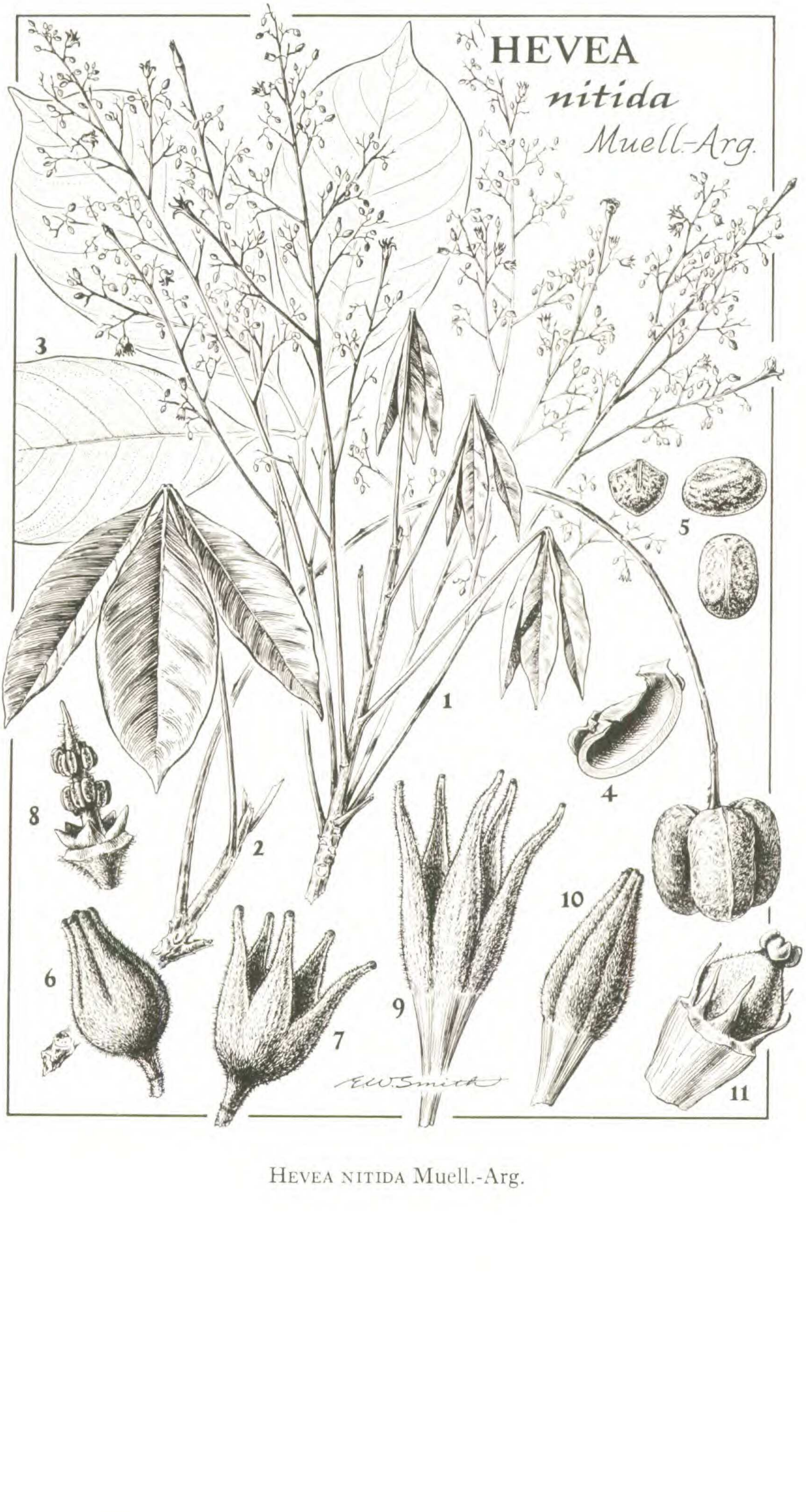
PLATE II. *Hevea nitida* Muell.-Arg. 1) Flowering branch with young leaves, about ½ natural size; 2) Fruiting branch, about ½ natural size; 3) Leaf variations, about ½ natural size; 4) Valve of capsule, about ½ natural size; 5) Seeds, about ½ natural size; 6) Staminate bud, about 5 × natural size; 7) Staminate flower, about 5 × natural size; 8) Staminal column with calyx removed, about 7½ × natural size; 9) Pistillate flower, about 5 × natural size; 10) Pistillate bud, about 5 × natural size; 11) Ovary with calyx removed, about 7½ × natural size.

PLATE III. *Hevea nitida* Muell.-Arg. var. *toxicodendroides* (Schult. & Vinton) R. E. Schultes. 1) Flowering branch, about ½ natural size; 2) Fruiting branch, about ½ natural size; 3 and 4) Leaf variations, about ½ natural size; 5) Valve of capsule and seeds, about ½ natural size; 6) Staminate bud, about 5 × natural size; 7) Staminate flower, about 5 × natural size; 8) Staminal column with calyx removed, about 7½ × natural size; 9) Pistillate flower with one calyx lobe removed, about 5 × natural size; 10) Pistillate bud, about 5 × natural size; 11) Ovary with calyx removed, about 7½ × natural size.

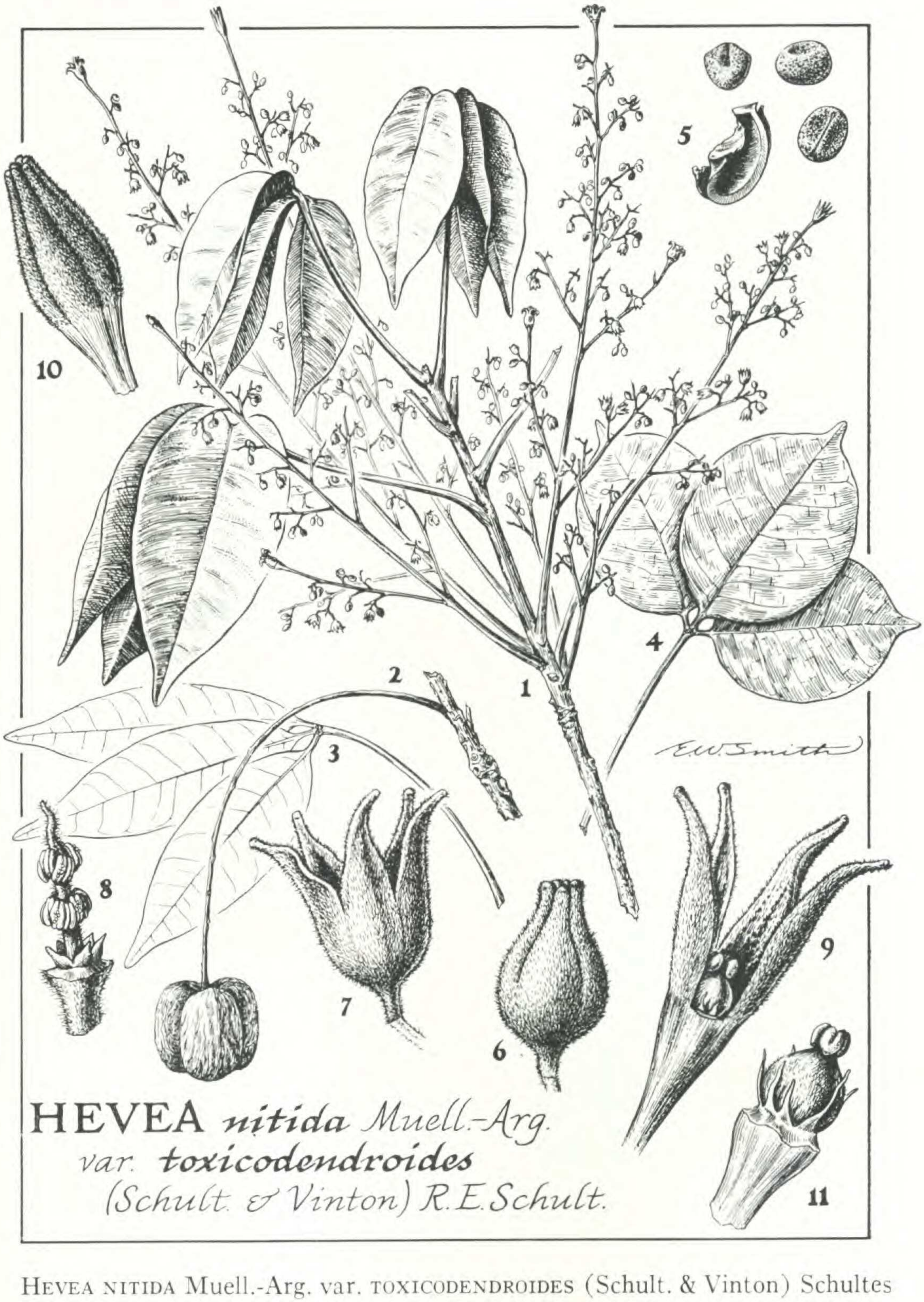
PLATE IV. *Hevea rigidifolia* (Spruce ex Benth.) Muell.-Arg. 1) Flowering branch, about ½ natural size; 2) Leaf variations, about ½ natural size; 3) Valve of capsule, about ½ natural size; 4 and 5) Seed, about ½ natural size; 6) Pistillate bud, about 5 × natural size; 7) Pistillate ffower, about 5 × natural size; 8) Ovary with calyx removed, about 7½ × natural size; 9) Staminate bud, about 5 × natural size; 10) Staminate flower, about 5 × natural size; 11) Staminal column with calyx removed, about 7½ × natural size.



HEVEA BENTHAMIANA Muell.-Arg.

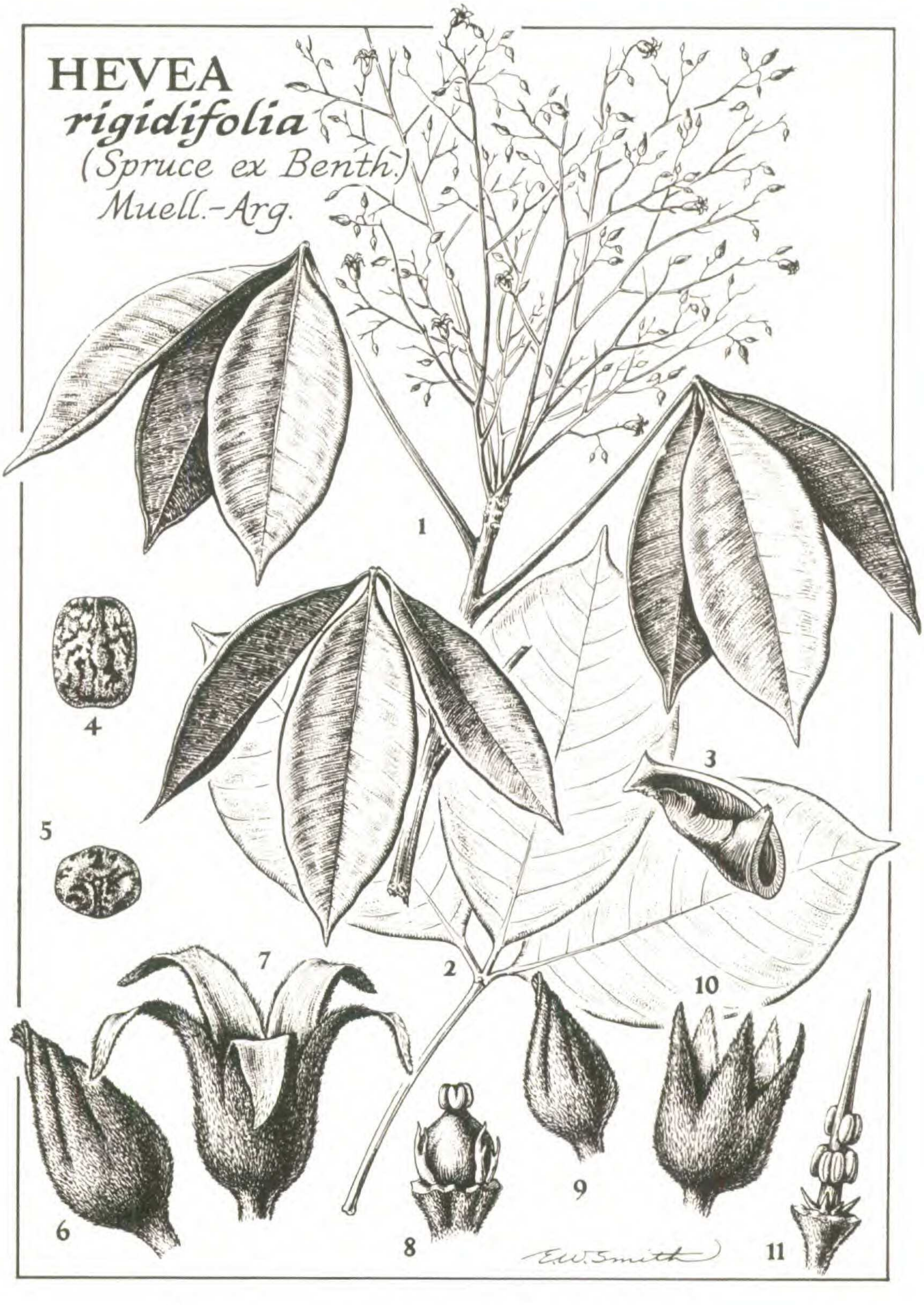


HEVEA NITIDA Muell.-Arg.



HEVEA *nitida* Muell.-Arg.
var. **toxicodendroides**
(Schult. & Vinton) R.E. Schult.

HEVEA NITIDA Muell.-Arg. var. TOXICODENDROIDES (Schult. & Vinton) Schultes



HEVEA RIGIDIFOLIA (Spruce ex Benth.) Muell.-Arg.